the measurement. Specifically, FIG. 9B shows the resultant sensed voltage of Sample IV as comprising a main signal lobe **103** which is relatively symmetrical about the center line **108** of the track **102**. Under the same testing conditions, Sample III is tested and the corresponding sensed voltage is shown in FIG. 9C, in which the peak amplitude of the main signal lobe **112** is recorded as somewhat diminished in value. The main signal lobe **112** is also skewed away from the center line **108** of the recording track **102**. More importantly, a side signal lobe **110** in addition to the main signal lobe **112** is clearly evident. This is an indication of possible undesirable domain formation in the magnetoresistive layer **74II**, due to the inadequacy of longitudinal bias. In essence, the existence of the side signal lobe **110** reveals that there is a possible secondary fringe region, active and independent of the central active region, residing in the magnetoresistive layer **74II**. Transducers thus built are not suitable for applications involving high density recording media.

These experimental results demonstrate that adequate longitudinal bias to the magnetoresistive layer of a thin-film magnetic transducer can be provided by the hard magnetic regions having a plurality of magnetized layers. Conversely, a transducer in which each of the hard magnetic regions includes only a uniform magnetized layer, may not be sufficient to provide the necessary magnetic bias to the magnetoresistive layer. As a consequence, the inadequate bias may fail to properly align the magnetoresistive layer in a single domain state, thereby causing considerable Barkhausen type noises and also yield sensed voltage of low signal-to-noise ratio.

Other variations are possible within the scope of the invention. For example, shown in FIG. 10 is another embodiment of the invention in which the transducer is designated by reference numeral **114**. FIG. 11 is a cross-sectional side view of the transducer **114** shown in FIG. 10. The transducer **114** comprises a tri-layer structure **116** having a spacer layer **118** sandwiched between a magnetoresistive layer **120** and a soft adjacent layer **122**. As in the preferred embodiment described above, magnetoresistive layer **120** includes end regions **120A** and **120B** spaced by a central active region **120C**. Disposed in contact with the end regions **120A** and **120B** are hard magnetic bias regions **124** and **126**, respectively. Hard magnetic bias region **124** comprises magnetized layers **124A** and **124B** spaced by an interposing layer **130**. In a similar manner, hard magnetic bias region **126** comprises magnetized layers **126A** and **126B** separated by another interposing layer **132**. It should be noted that in this embodiment, hard magnetic bias regions **124** and **126** are disposed atop and in contact with the respective end regions **120A** and **120B** of magnetoresistive layer **120**. In comparison with the prior art transducers, such as transducers **2** and **20** shown in FIGS. 1 and 2, respectively, hard magnetic regions **124** and **126** can be fabricated with a thinner thickness t', and still provide sufficient longitudinal magnetic bias to magnetoresistive layer **120**. The consequential benefit is that the intermediate layer **77**, between the magnetic shield layer **54** and the electrical leads **64** and **66**, can be deposited with better step coverage which in turn, minimizes the probability of generating electrical shorts between regions **64A** and **68A** of electrical leads **64** and **68**, respectively, to the magnetic shield **54**. A thinner hard film layer provides improved planarization of the magnetic poles. Consequently, higher manufacturing yield and improved operational reliability is thereby made possible.

For all the embodiments as depicted, the materials used need not be restricted as described. Furthermore, each of the hard magnetic bias regions can be deposited with more than two magnetized layers. In addition, the magnetized layers in any of the hard magnetic bias regions need not be made of the same material, and further need not assume the same number of layers as the other corresponding magnetic bias region within the same transducer. These and other changes in form and detail may be made therein without departing from the scope and spirit of the invention as defined by the appended claims.

What is claimed is:

1. A thin-film magnetoresistive transducer comprising:

a magnetoresistive layer formed of ferromagnetic material, said magnetoresistive layer including end portions spaced by a central active portion; and

first and second magnetic bias regions, each of said magnetic bias regions including a plurality of magnetized layers formed of hard magnetic material disposed in direct contact with one of said end portions of said magnetoresistive layer, wherein the plurality of magnetized layers in said first and second magnetic bias regions cooperatively provide a magnetic bias to said magnetoresistive layer.

2. The thin-film magnetoresistive transducer as set forth in claim **1** wherein said magnetic bias is a longitudinal magnetic bias, said transducer further comprising a soft adjacent layer disposed parallel to and separated from said magnetoresistive layer by a spacer layer, said soft adjacent layer providing a transverse magnetic bias to said magnetoresistive layer.

3. The thin-film magnetoresistive transducer as set forth in claim **2** wherein said soft adjacent layer comprises an alloy of nickel, iron and rhodium and wherein said spacer layer comprises tantalum.

4. The thin-film magnetoresistive transducer as set forth in claim **3**, including two magnetic shields formed of soft magnetic material, wherein said magnetoresistive layer, said first and second magnetic bias regions, said soft adjacent layer and said spacer layer are disposed between said two magnetic shields.

5. The thin-film magnetoresistive transducer as set forth in claim **1** wherein each of said magnetized layers comprises an alloy of cobalt, chromium and platinum.

6. The thin-film magnetoresistive transducer as set forth in claim **1** wherein each of said magnetized layers comprises an alloy of cobalt, chromium and tantalum.

7. The thin-film magnetoresistive transducer as set forth in claim **1** wherein each of said magnetized layers comprises an alloy of cobalt, chromium, tantalum and platinum.

8. The thin-film magnetoresistive transducer as set forth in claim **1** wherein each of said magnetized layers comprises an alloy of cobalt, chromium, platinum and boron.

9. The thin-film magnetoresistive transducer as set forth in claim **1** wherein said magnetoresistive layer comprises a Nickel-iron alloy.

10. The thin-film magnetoresistive transducer as set forth in claim **1** wherein said magnetized layers are spaced from each other by interposing non-magnetic layers.

11. The thin-film magnetoresistive transducer as set forth in claim **1** further comprising a non-magnetic